A "New" Lake Elsinore: Physical, Chemical, and Ecological Changes that Resulted from the Region's Winter Storms

Rebecca Lawson and Michael A. Anderson University of California, Riverside Department of Environmental Sciences

INTRODUCTION

- Lake Elsinore is the largest natural lake in Southern California.
- In such an arid climate, scarcity of water supply is a dominant factor in water quality for Lake Elsinore.
- From 1999 to 2004 the region was in a drought period, and the lake level and water quality of the lake had declined dramatically.
- A destratification system was installed in July 2004 to increase mixing and help aerate the lake.
- The winter storms of 2005 increased the volume of Lake Elsinore from about 25,000 acre-feet to greater than 80,000 acre-feet.

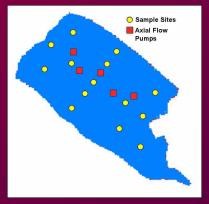
OBJECTIVE

- To quantify the limnological changes to Lake Elsinore as a result of near record rainfall.

METHODS

- Water column properties were measured bi-weekly to monthly at 14 sites using a Hydrolab.
- Transparency was determined using a Secchi disk.
- Water samples were also collected and analyzed for dissolved and total nutrients, and chlorophyll.
- In July of 2005 two strings of temperature loggers were deployed for one month at 10 m and 100 m from one of the axial flow pumps.

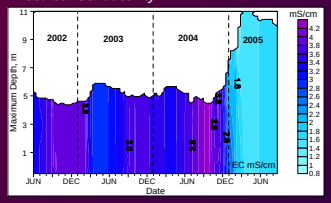
Lake Elsinore



Axial Flow Pump on Lake Elsinore

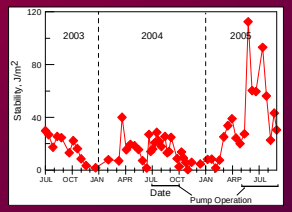
RESULTS AND DISCUSSION

Electrical Conductivity

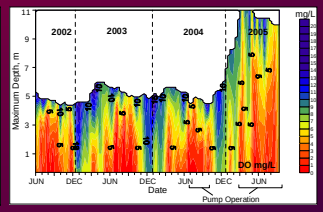


- Winter storms in 2005 doubled the maximum depth of the lake from approximately 5 m to 11 m.
- Runoff substantially lowered electrical conductivity from greater than 4 mS/cm to 1.5 mS/cm.
- The spring of 2005 represents the lowest EC values in the past three years.

Thermal Stability



Dissolved Oxygen



- Thermal stability was determined using data from the 14 monitoring sites and calculated with the Schmidt stability equation:

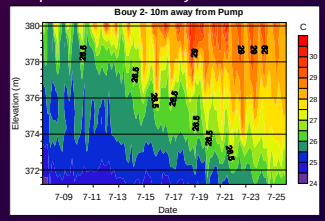
$$S = \frac{g}{A_0}\int_{z_0}^{z_n}(z - z^*)(\rho_z - \rho^*)A_z dz$$

- Thermal stability represents the amount of energy (J/m²) required to completely mix the water column.
- Thermal stability varied seasonally, with higher values present in the summer and low values in the winter.
- Higher values in 2005 were associated with the greater lake depth, with more prolonged periods of stratification compared with the shallower lake.

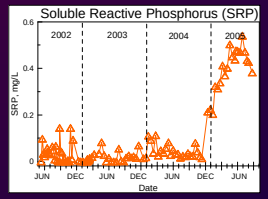
- Dissolved oxygen varied quite strongly both seasonally and with depth.
- Low DO values in the summer coincided with periods of thermal stratification and higher thermal stabilities.
- High thermal stabilities and low DO levels were present despite axial flow pump operation beginning in the early spring.

- Strong thermal gradients were found within 10 m of the axial flow pump.
- Daytime surface heating and night time cooling occurred.
- The two strings of temperature loggers showed similar profiles, indicating little or no effect from the axial flow pump on stratification in the lake.

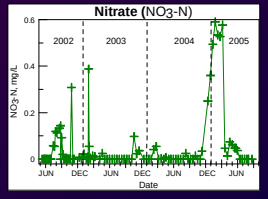
Temperature Profile for July 2005



Dissolved Nutrients

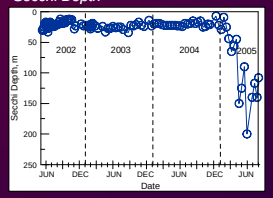


- Soluble reactive phosphorus (SRP) concentrations have been comparatively low through 2004 with values near 20 ug/L.
- Concentrations increased strongly in 2005 due to storm runoff.



- Dissolved nitrate concentrations also strongly increased in the spring of 2005 due to storm runoff.
- Algal uptake and denitrification associated with anoxia are presumably responsible for the observed loss in NO_3-N found later in the spring and summer.

Secchi Depth



- Lake transparencies measured as Secchi depths were extremely low with little variation in the past three years when compared to the sharp increase in transpariencies after the storms in 2005.

Phytoplankton Community

Phytoplankton in Lake Elsinore
a. June 2004 - Oscillatoria;
b. Asterionella and other diatoms, and green algae

- The phytoplankton community shifted form an *Oscillatoria*-dominated community in June of 2004 to a population that included a large portion of diatoms and green algae observed in June of 2005.
- The occurrence of green algae and diatoms coincided with increased lake levels, increased available nutrients, and reduced EC.

Chlorophyll Concentrations and Zooplankton Populations in Lake Elsinore

	Chlorophyll	Population individuals/L			
Date	ug/L	*Daphnia*	*Bosmina*	*Keratella*	*Copepods*
June-04	157	0.7	<10	258	381
June-05	22.1	188	234	97	209

- Chlorophyll levels in June of 2005 were dramatically lower that those of June of 2004, and coincided with the sharp increase in Secchi depth.
- The zooplankton community had changed significantly over the past year.
- Cladoceran populations increased strongly while rotifer and copepod populations declined.

CONCLUSIONS

- The 2005 winter storms had a dramatic effect on the physical, chemical, and ecological properties of Lake Elsinore.
- Thermal stabilities increased as lake depth increased, while DO profiles showed similar trends both before and after the storms. Low DO concentrations were found near the sediments.
- DO and temperature profiles displayed strong vertical gradients even during axial flow pump operation.
- Reduced salinity (EC) and altered phytoplankton community had a strong positive effect on the cladoceran population.
- The high *Daphnia* populations are thought to control phytoplankton productivity in Lake Elsinore even in the presence of high available nutrient levels.